

**Iowa Department of Natural Resources
Environmental Protection Commission**

ITEM

4

DECISION

TOPIC

Contract – Iowa State University – Wetland Performance Monitoring

The Department requests Commission approval of a \$249,890 contract with Dr. William Crumpton to conduct wetland performance monitoring.

The objective of this program is to determine the effectiveness of Iowa wetlands in reducing phosphorus loading to Iowa streams and lakes. The Iowa Department of Agriculture and Land Stewardship is currently providing funding to ISU in a five year project to determine reductions in nitrogen that occur in CREP wetlands. This project builds upon that existing framework to also expand into phosphorus monitoring. Monitoring the phosphorus balance of wetlands in Iowa's landscape is an important component in understanding water quality because it is unclear whether wetlands reduce phosphorus loading or in fact may increase phosphorus loading in some situations. This contract covers 18 months of a five year project as indicated by the budget below. The contract covers the following items:

- The contractor will collect water samples and measure flow rates at major inflows and outflows of each selected wetland during the primary period of flow from just after thaw to just before freezing.
- The contractor will analyze inflow and outflow water samples for phosphorous fractions and calculate phosphorous mass balances for each wetland.
- The contractor will collect other ancillary data and information relevant to the cycling of phosphorus in wetlands.
- Contractor will transfer all chemical data results to DNR in electronic form for submittal to the Iowa STORET database.
- The contractor will submit a report detailing the results of the work, the implications for wetland mitigation, and suggestions for future work.

Funding for this contract comes from the Environment First Infrastructure Funds – Water Quality Monitoring Funds.

Mary Skopec
Section Supervisor
Water Monitoring and Assessment
Iowa Geological Survey and Land Quality Bureau
Environmental Services Division

June 10, 2007

	6/1/2005- 6/30/2007	7/1/2007- 12/31/2008	1/1/2009- 12/31/2009	1/1/2010- 12/31/2010	5 yr Total
Salaries & wages					
Research Associate (P&S)	\$105,261	\$130,099	\$77,061	\$79,372	\$391,793
P.I.	\$8,190	\$8,688	\$8,949	\$9,217	\$35,044
Hourly	\$15,897	\$28,000	\$19,000	\$19,500	\$82,397
Total Salaries & wages	\$129,348	\$166,787	\$105,010	\$108,089	\$509,234
Benefits					
Research Associate (P&S)	\$34,210	\$42,282	\$25,045	\$25,796	\$127,333
P.I.	\$2,179	\$2,311	\$2,380	\$2,452	\$9,322
Total Benefits	\$36,389	\$44,593	\$27,425	\$28,248	\$136,655
Travel	\$9,000	\$6,000	\$6,000	\$6,000	\$27,000
Materials \$ Supplies	\$21,000	\$14,000	\$14,000	\$14,000	\$63,000
Total Direct Costs	\$195,737	\$231,380	\$152,435	\$156,337	\$735,889
Indirect Costs (@ 8% of direct costs)	\$15,659	\$18,510	\$12,195	\$12,507	\$58,871
TOTAL	\$211,396	\$249,890	\$164,630	\$168,844	\$794,760

This contract is entered into between the Iowa Department of Natural Resources (DNR) and Iowa State University (Contractor)]. The parties agree as follows:

Section 1 **IDENTITY OF THE PARTIES**

1.1 Parties. DNR is authorized to enter into this contract. DNR's address is: Wallace State Office Building, 502 East 9th Street, Des Moines, Iowa 50319.

Iowa State University is a public university is organized under the laws of the State of Iowa and authorized to do business in the State of Iowa. The Contractor is the Iowa State University Department of Ecology, Evolution, and Organismal Biology (Contractor). The Contractor's address is: Iowa State University, 3609 Administrative Services Building, Ames, IA 50011-3609.

1.2 Project Managers. Each party has designated a Project Manager, who shall be responsible for oversight and negotiation of any contract modifications, as follows:

DNR Project Manager: Dr. Mary Skopec
Geological Survey Bureau
109 Trowbridge Hall
Iowa City, IA 52242-1319
(319) 335-1579
mskopec@igsb.uiowa.edu

Contractor Project Manager: Dr. William Crumpton
ISU, EEOB, 253 Bessey Hall
Ames, IA 50011-1020
(515) 294-4752
crumpton@aistate.edu

STATEMENT OF PURPOSE

2.1 Authority. DNR has the authority to enter into contract according to the provisions of Iowa Code section 455B.103(3)¹.

2.2 Purpose. The parties have entered into this contract for the purpose of retaining the Contractor to provide DNR with information to assess the water quality performance of selected Iowa wetlands representing a range of hydraulic and nutrient loading conditions. Phosphorous concentrations and flow shall be monitored at between 8 and 10 wetlands each year, and phosphorous mass balances shall be calculated for each. By design, the wetlands selected for monitoring shall span a broad range of hydraulic loading rates. For close interval monitoring of phosphorous concentrations, selected wetlands shall be instrumented with automated samplers from approximately April through October to collect daily composite water samples at wetland inflows and outflows. In addition, weekly grab samples shall be collected from the inflow and outflow of each wetland monitored by automated samplers as well as other wetlands without automated samplers. The samples shall be analyzed for phosphorous fractions and the data used to calculate mass phosphorous load, mass phosphorous export, mass phosphorous removal, and phosphorous removal efficiency (as percent phosphorous reduction) for each wetland. Mass balance simulation models shall also be run for each wetland using measured

¹ Iowa Code section 455B.103 states, in relevant part, that "[t]he director shall: 3) Contract, with the approval of the commission, with public agencies of this state to provide all laboratory, scientific field measurement and environmental quality evaluation services necessary to implement the provisions of this chapter, chapter 459, and chapter 459A."

concentrations and flows as forcing functions, and results compared with measured phosphorous export and removal by the wetlands. In addition to documenting performance of wetlands in phosphorous removal, the mass balance analyses and modeling shall be used to improve and extend mass balance performance models for use in the siting of future wetland restorations.

DURATION OF CONTRACT

3.1 Term of Contract. The term of this contract shall be July 3, 2007, through December 31, 2008, unless terminated earlier in accordance with the Termination section of this contract.

3.2 Approval of Contract. If the amount of compensation to be paid by DNR according to the terms of this contract is equal to or greater than \$25,000.00 (twenty five thousand dollars), then performance shall not commence unless by July 3, 2007 this contract has been approved by the Environmental Protection Commission.

3.3 Renewal. The parties may renew and extend this contract for subsequent periods by executing a signed contract prior to the expiration of this contract.

Section 5 STATEMENT OF WORK

5.1 Statement of Work. The Contractor shall perform the work to characterize the performance of Iowa wetlands as described in the Workplan, which is attached as Exhibit A and is by this reference made a part of this contract. In addition and by the Task Milestone Dates set out below, the Contractor shall provide the following Deliverables to DNR:

5.1.1 The Contractor shall provide nutrient monitoring at a set of wetlands representing a range of hydraulic conditions and landscape factors.

5.1.2. The Contractor shall collect water samples and measure flow rates at major inflows and outflows of each selected wetland during the primary period of flow from just after thaw to just before freezing.

5.1.3 The Contractor shall analyze inflow and outflow water samples for phosphorous fractions and calculate phosphorous mass balances for each wetland.

5.1.4 The Contractor shall conduct the laboratory analyses using methods agreed upon by DNR and shall document any deviations from standard methods.

5.1.5 The contractor shall prepare a Quality Assurance Program Plan in conjunction with DNR staff.

5.1.6 The contractor shall provide an oral report at an annual data conference if requested by DNR.

5.1.7 By July 3, 2007, the Contractor shall commence all fieldwork to be performed according to the terms of this contract.

5.1.8 By January 31, 2008, the Contractor shall submit to DNR a written report summarizing data collected during the summer of 2007.

5.1.9 By December 15, 2008 the Contractor shall submit to DNR a written report summarizing the data collected during the summer of 2008.

5.1.10 The Contractor shall submit written monthly reports as required by section 6.2 Status Reports.

Exhibit A
Workplan: Water Quality Performance of Iowa Wetlands
Dr. William Crumpton

Much of the Midwest corn belt was historically rich in wetlands, and in some areas, farming was made possible only as a result of extensive wetland drainage. We now recognize the important functions that wetlands had served in this landscape, and there is considerable interest in recovering these lost functions. Since the mid-1980s, a variety of state and federal programs have been used to promote wetland restoration in the region, and over the next few years, many thousands of wetland acres will be restored under these programs. These continuing efforts provide a unique opportunity for control of agricultural non-point source pollution. However, until recently wetland restorations have been motivated primarily by concern over waterfowl habitat loss, and site selection criteria for wetland restorations have not always considered water quality functions. Many wetland restorations in the southern prairie pothole region drain small areas and despite significant habitat value, these wetlands may intercept insufficient contaminant loads to significantly affect water quality. This does not lessen the promise of wetland restoration for water quality improvement in agricultural watersheds but rather underscores the need for explicitly considering water quality endpoints when planning wetland restorations (Crumpton 2001). Iowa's wetland programs are increasingly addressing water quality objectives and there is a pressing need for understanding the water quality performance of Iowa's wetland.

A major initiative of the Iowa State University Wetlands Research Group specifically addresses the hydrologic and water quality functions of wetlands in agricultural watersheds. This research effort uses mass balance analysis and modeling to integrate work over a range of spatial and temporal scales from short-term process studies in experimental wetland mesocosms to long-term modeling and analysis of watersheds. This research provided the scientific and technical foundation for development and implementation of the Iowa Conservation Reserve Enhancement Program (CREP). Controlled studies in experimental wetlands were used to examine nitrate transformation and loss in wetlands and elucidate the environmental factors controlling nitrate loss. Results from experimental wetlands were used to develop a general model for nitrate loss that was calibrated and validated against field data, combined with a hydrologic loading model to simulate nitrate loading and loss for wetlands in agricultural watersheds, and integrated into a watershed scale framework for siting wetlands for water quality improvement (Crumpton et al 1997, Crumpton and Goldsborough 1998, Crumpton et al in prep, Crumpton 2001). This work has shown that wetlands can improve water quality at the watershed scale if they are sited and designed to intercept a significant portion of the subsurface water moving through a watershed. Performance-forecast models developed from this work have shown that strategically located and designed wetlands have the potential to remove more than half of the nitrate in tile drainage water from upper-lying croplands. A unique aspect of the Iowa CREP is that these expected water quality benefits will not simply be assumed based on wetland acres enrolled but will in fact be calculated based on the measured performance of CREP wetlands. As an integral part of the Iowa CREP, a representative subset of wetlands is being monitored and mass balance analyses performed to document nitrate reduction across a wide range of nutrient and hydrologic loading conditions. This has required a substantial investment in infrastructure and monitoring capabilities, but resources are only available for monitoring nitrate.

The additional monitoring and assessment proposed here would build upon the existing infrastructure and capabilities of the ongoing monitoring program. The proposed research would add phosphorous loading and mass balance studies to ongoing nitrate monitoring studies and would encompass an even wider range of nutrient and hydrologic loading conditions. This strategy reduces monitoring costs by approximately 50% and provides for effective coordination of agency programs in this area.

The case of phosphorous is complicated by the lack of data on bioavailable phosphorous. Bioavailable phosphorous includes 1) dissolved inorganic P, 2) nonoccluded particulate inorganic phosphorous that is sorbed to surfaces and freely exchangeable with the water phase, and 3) labile forms of organic phosphorous that are easily hydrolyzed by phosphatase enzymes. However a significant fraction of phosphorous found in surface

The candidate sites span an order of magnitude in Hydraulic Loading rate, from less than 5 m/year to more than 60 m/year (Figure 2). The wetlands are also expected to span a broad range of incoming phosphorous concentrations (although phosphorous loads have not been estimated, nitrate concentrations at the candidate sites varied by an order of magnitude). The wetlands thus provide a broad spectrum of those factors most affecting wetland performance: hydraulic loading rates, residence times, nutrient concentrations, and nutrient loading rates.

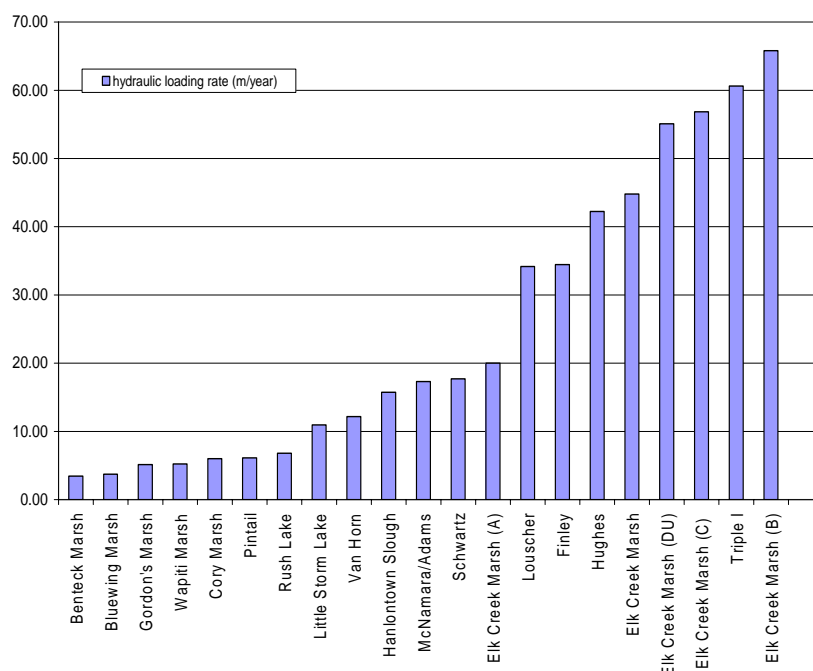


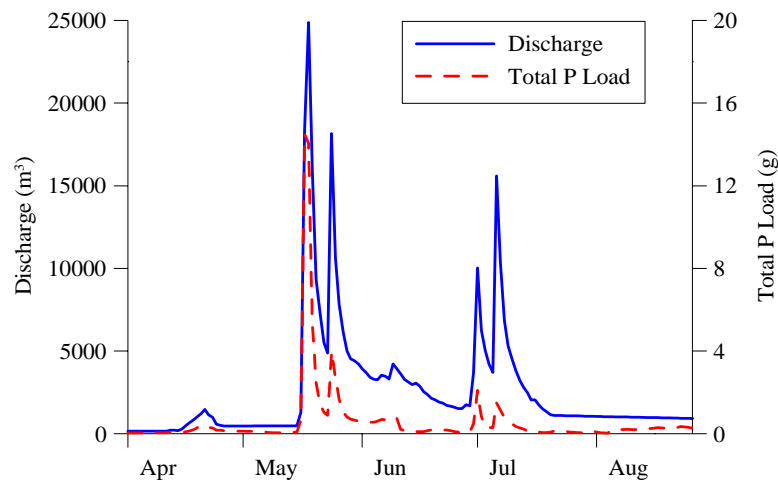
Figure 2. Hydraulic loading rates of candidate sites for monitoring of phosphorous retention performance of Iowa wetlands.

A subset of sites has been identified for intensive monitoring, but selection of final sites will be based on sampling and site analyses conducted during the first few months of the project. Plans are to monitor approximately 8-10 basins each year assuming two autosamplers per wetland. The number of basins monitored could be lower if basins require more autosamplers due for example to multiple inputs or separate monitoring of surface runoff and subsurface tile inputs.

Sampling schedule

Phosphorus concentrations in agricultural streams display tremendous variability, and peak concentrations can occur during either very low or very high flow periods. However, phosphorus loading is strongly correlated with water flow. This is particularly true in small watersheds where water flow is low during much of the year but increases dramatically and rapidly following a rain event. This is illustrated in Figure 3 for 2004 data collected from a small watershed in northwest Iowa. It is during high water flow periods in such systems that accurate estimates of phosphorus concentrations are most critical for estimating loads. It is not possible to accurately estimate phosphorous loads from weekly grab samples. Automated sampling is necessary to capture flow dependent loading events. Wetlands will be instrumented with automated samplers to collect daily composite water samples at wetland inflows and outflows starting in the early spring, as soon as the soil begins to thaw, through late fall, when the soil begins to freeze. The automated sampling equipment will be programmed to collect daily composite water samples each composed of sub-samples collected into a single sampling bottle at regular intervals. In addition, grab samples will be collected year round from wetland inflows and outflows. All samples will be preserved by acidification with sulfuric acid.

Figure 3. 2004 data for site 48S on Spring Run Creek in County, Iowa.



To address the need for close interval sampling during high flow periods and simultaneously control the total number of sample analyses, a flow proportionate sample analysis strategy will be used. In this system, although daily composite samples are collected, a sample is analyzed only for a proportionate increment of flow during the sampling period. Accordingly, samples analyses are not necessarily performed on each sample that is collected. This flow-proportionate sample analysis procedure places the majority of analyses during high water flow events with fewer analyses during periods of low flow. To avoid excessive time intervals between analyses during low flow periods, samples will be analyzed at least weekly. Although the total flow is not known prior to the end of the sampling season (or year), the flow-proportionate sample analyses procedure may be approximated on the basis of historic flow data for a site in conjunction with current real time flow data. Sample analyses would be conducted daily during high flow events and at least weekly during low flow events. At the end of the sampling season, a more precise flow proportionate analysis may be carried out to determine if additional analyses need to be conducted for stored samples to insure that an adequate number of analyses are available for an accurate estimate of loading rates. This flow-proportionate sample analyses strategy is illustrated in Figure 4. As illustrated, the strategy results in more frequent sample analysis during periods of high flow and less frequent analyses during periods of lower flow. The procedure is expected to generate 100-150 samples per site per year (200-300 samples per wetland per year assuming two autosampler sites per wetland).

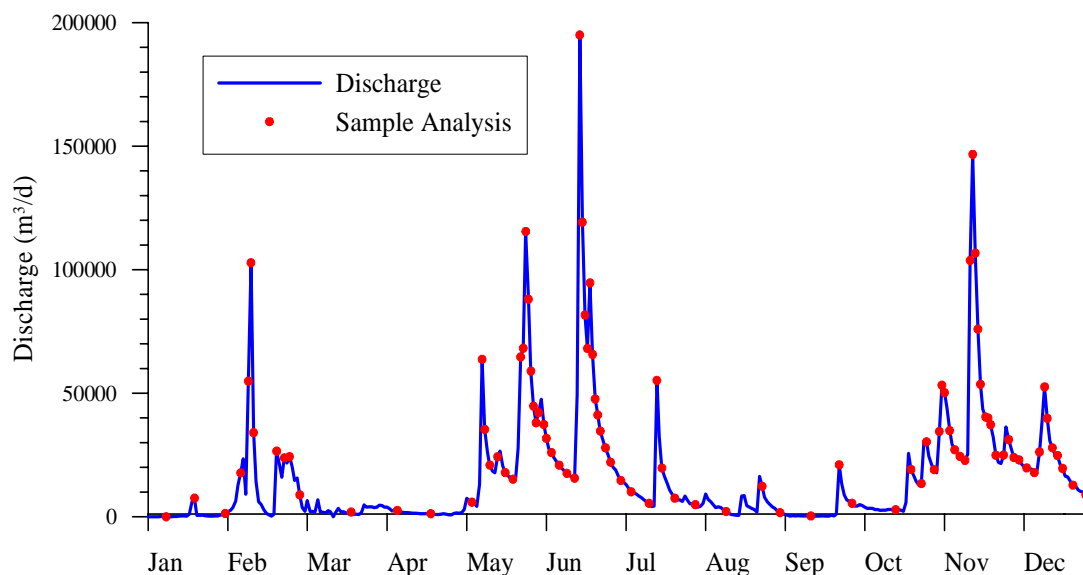


Figure 4. Flow-proportionate sampling example based on flows in Walnut Creek in Story County, Iowa.

Sample analyses

Phosphorus occurs in water in multiple forms. Of those which are bioavailable, some are readily available while others are available only after some shift in equilibrium or enzymatic action (Uusitalo, 2004). Other refractory and particle bound forms are not bioavailable. For total phosphorus, samples will be digested using persulfate digestion (AWWA, 1998) or high temperature combustion/hydrolysis (Solarzano and Sharp 1980) and analyzed using the colorimetric ascorbic acid molybdenum blue method (Murphy and Riley, 1962). For bioavailable phosphorus, samples will be analyzed for forms of phosphorus that are recovered through desorption or digestion with phosphatases. Samples will be incubated with anion exchange resin and phosphatase enzymes concurrently. The resin serves as a trap for dissolved phosphate initially present, for freely exchangeable phosphate as it desorbs from the particulate phase, and for phosphate formed by hydrolysis of labile organic compounds. After incubation, the phosphorous trapped on the resin will be released and analyzed using the colorimetric ascorbic acid molybdenum blue method (Murphy and Riley, 1962). Depending on results, these estimates may be compared with phosphorous recovered by mild acid hydrolysis.

For some samples, bioavailable forms will be separated for assay. A series analysis will be used in which bioavailable inorganic phosphorus is first removed using an anion exchange trap and assayed. The remaining organic fraction is then subjected to enzymatic hydrolysis and assayed.

Mass balance analyses

Phosphorous concentration and flow data used to calculate mass phosphorous load, mass phosphorous export, mass phosphorous removal, and phosphorous removal efficiency (as percent phosphorous reduction) for each wetland. Mass balance simulation models will also be run for each wetland using measured concentrations and flows as forcing functions, and results compared with measured phosphorous export and removal by the wetlands.

- Crumpton, W.G. 2001. Using wetlands for water quality improvement in agricultural watersheds: The importance of a watershed scale approach. *Water Science and Technology* 44:559-564.
- Crumpton, W.G., and L.G. Goldsborough. 1998. Nitrogen transformations and fate in prairie wetlands. *Great Plains Research* 8:57-72.
- Crumpton W.G., G. Atchison, A. van der Valk, C. Rose, E. Seabloom, S. Beauvais, J. Stenback, S. Brewer. 1997. Ecological fate and effects of agrichemicals in surface waters of the western cornbelt ecoregion: Wetland functions. Project completion report, USEPA.